SUMMARY

RESOURCE AND POTENTIAL RECLAMATION EVALUATION

KIMBETO STUDY AREA

REPORT NO. 17-77

U.S. Department of the Interior

au of Land Management —— Bureau of Reclamation —— Geological Survey

September 1981

Kimbeto Study Area Report
Published September 1981

The Federal Coal Management Program has been designed as an interagency cooperative effort to meet national energy objectives.

"Kimbeto" Study Area Report was prepared through the efforts of the U.S. Department of Interior, principally the Bureau of Land Management, Geological Survey, and Bureau of Reclamation. The study effort began in 1977 and was concluded in 1981 with the publication of this report.

The area described in this report has been tentatively determined to be a potential Federal coal development area. The purpose of this report is to provide information on the area's reclamation potential should coal development occur. This report will assist managers in making final Federal coal leasing decisions.

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Denver, CO 80225
303-234-2374

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. BLM-YA-PT-81-009-7330

2.

3. Recipient's Accession No.

4. Title and Subtitle
Kimbeto Study Area Report: Resource and Potential Reclamation Evaluation Summary

5. Report Date
September 1981

6.

7. Author(s)
Bureau of Reclamation, Dick Griese (ED)

8. Performing Organization Rept. No.
17-77

9. Performing Organization Name and Address
Bureau of Reclamation
Commerce Bldg., Suite 201
714 S. Tyler
Amarillo, TX 79101

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
BLM New Mexico State Office
U.S. Post Office and Federal Bldg.
P.O. Box 1449
Santa Fe, NM 79101

13. Type of Report & Period Covered
Summary 1977-1981

14.

15. Supplementary Notes
Prepared jointly by Bureau of Land Management, Bureau of Reclamation and Geological Survey

16. Abstract (Limit: 200 words)

Report provides information on reclamation potential (and on coal resources) of study area (SA) should coal development occur. SA is located in San Juan County, New Mexico. Restoration of existing levels of vegetation is recommended. Irrigation required for 2 years. Thirty-five percent of surface of SA has suitable planting media. Much of SA is badlands. Many soils are saline or sodic. Bedrock generally not suitable planting media in present state. Revegetation will be difficult because of semiarid climate. Subbituminous coal beds average 5.4 feet in thickness; 68 percent of coal is overlain by 200 feet or less of overburden. Measured and indicated coal with less than 400 feet of overburden are 69.1 million and 369.1 million short tons. Average Btu value, ash content, and sulfur content is 8,250, 23.4 percent, and 0.5 percent. Considering geochemical factors, bedrock should not adversely affect ground water element concentrations. SA has low vegetative productivity. Several species, especially galleta and alkali sacaton, would be effective in revegetation of the SA. Hydrology or water quality considerations should not cause problems with mining or reclamation. Surface and ground water supplies suitable for irrigation may be available.

17. Document Analysis a. Descriptors
0510 Environmental Surveys
0807 Coal Deposits
1407 Reclamation

b. Identifiers/Open-Ended Terms Mined-land reclamation, New Mexico

c. COSATI Field/Group

18. Availability Statement
Release unlimited
BLM, New Mexico State Office, U.S. Post Office and Federal Bldg., P.O. Box 1449, Santa Fe, NM 87501

19. Security Class (This Report) unclassified

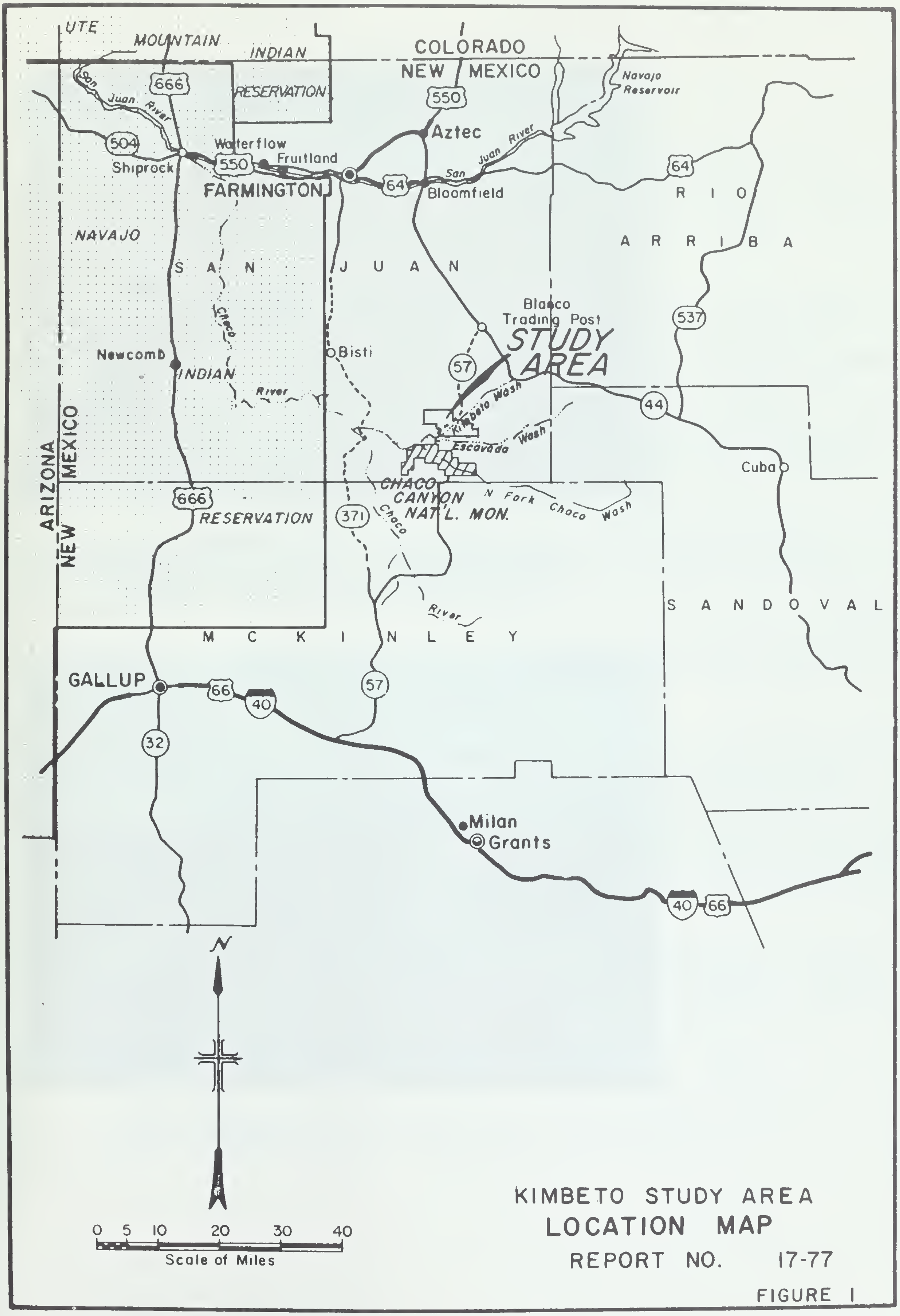
20. Security Class (This Page) unclassified

21. No. of Pages

22. Price

(See ANSI-Z39.18) See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce



KIMBETO STUDY AREA
LOCATION MAP
REPORT NO. 17-77

FIGURE 1

Photo 1. View showing typical and important features of study area--Class 2 land in foreground, badlands in middleground, and mesa in far background. (Photo taken looking east near profile 19.)

Photo 2. Class 1 land with good vegetative cover. (Photo taken looking southwest near profile 27.)

OVERVIEW OF RECLAMATION

Potential for Reclamation

Lands of the Kimbeto study area* will provide material suitable as planting media (when placed on shaped spoils). There is enough suitable material to allow postmining revegetation at about existing levels of vegetative cover provided the Recommendations for Reclamation presented below are followed. Other recommendations in this summary should also be followed for successful reclamation.

Most materials suitable as planting media are found on the surface, both at higher elevations and (as eolian deposits) on the valley lands. These materials are generally coarse, moderately coarse, or moderately fine; have adequate permeability; and are usually nonsaline and nonsodic. About 35 percent of study area lands were identified as having suitable materials. Figure 2 shows the results of the land classification survey, which was made to determine the location of lands with material suitable for use as planting media. Lands in classes 1 (good) and 2 (fair) have strippable quantities of suitable material; lands in class 6 have materials which are unsuitable in their present condition but which may be suitable under special management.

Because of salinity and restricted permeability resulting from sodium and swelling-type clays, bedrock overburden is generally not suitable as planting media. There is a possibility of limited use of such overburden under special management.

The harsh climate, typical of arid areas in this region and characterized by low precipitation occurring in erratic patterns, will make revegetation difficult.

Recommendations for Reclamation

Four alternatives regarding postmining reclamation were considered--no mining, natural recovery, total revegetation, and restoration of existing levels of vegetation. Of these, restoration of existing levels of vegetation is recommended. Under this alternative, the entire study area would be carefully graded, and existing levels (at least) of vegetation would be restored. Areas not revegetated would be reclaimed so as to minimize erosion and then allowed to revegetate naturally. The recommendations that follow apply to the restoration of existing levels of vegetation alternative.

Before mining, a detailed study should be made to more precisely establish the nature and location of soils and bedrock suitable for planting media. During mining, these materials should be carefully stockpiled and protected. All toxic materials should be buried below the root zone. Soils and bedrock classed as

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* The study area covers a 12,160-acre area (about 20 square miles).

unsuitable are not recommended for use as planting media in their present conditions but should be further investigated for such use under special management.

After mining, the study area should be carefully graded to blend with surrounding land forms, utilize rainfall, promote revegetation, provide drainage, and minimize erosion. In order to reduce erosion and sediment yield, wide, flat drainageways should be constructed in the reshaped topography to accommodate flows that originate on the reclaimed area and upstream.

Selected graded areas should be covered first with about a foot of moderately fine textured soil; then about 16 inches of suitable coarse-textured soil should be placed over the finer material. The lower layer will promote water retention and the upper layer will promote permeability. Soil types could also be mixed as appropriate to improve the poorer materials. The use of fertilizer before, during, and after seeding may be desirable. Seeding should be done carefully, preferably with the drill method. Species (native and of local origin), seed mixes, seeding rates, and seeding times determined by the reclamation manager to be appropriate to local conditions should be used.

Irrigation is recommended for about 2 years following seeding in order to establish vegetation. A firm water supply for irrigation should be established, which may be difficult at the Kimbeto study area.

After seeding, soil surfaces should be protected by mulches and wind barriers. Temporary use of herbicides on annual weeds may be necessary. Vegetation should be protected from grazing of domestic livestock until established.

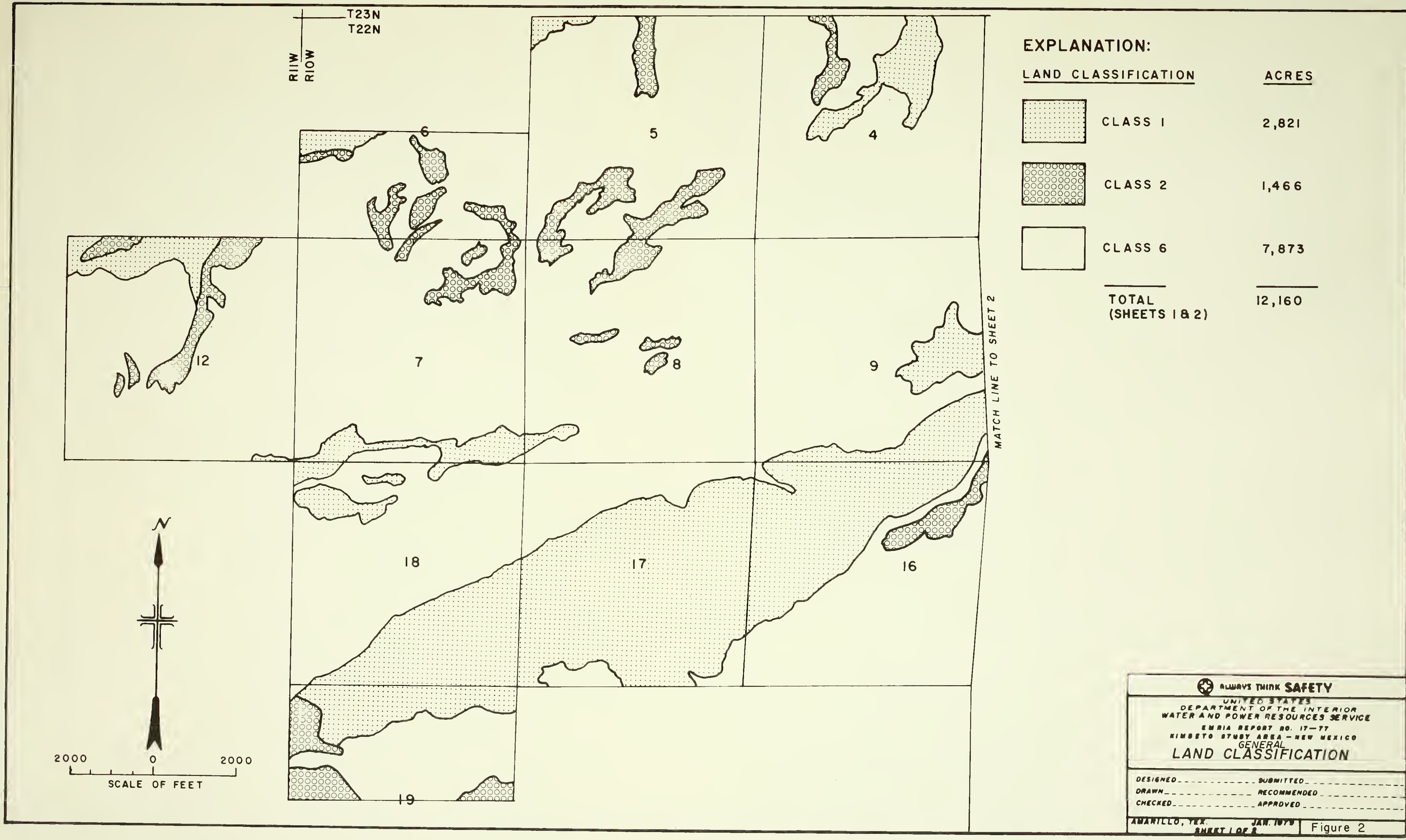
CLIMATE

The Kimbeto study area has an average annual temperature of 49° F, ranging from 27.5° F in January to 73.1° F in July. The frost-free season is about 106 days. Average annual precipitation, usually in the form of localized intense thunderstorms, is about 8.8 inches, with July, August, September, and October each averaging over 1 inch. The remaining months each average about 0.5 inch. The 8.8 inch average includes years with 3 inches and years with 14 inches. Up to 7 inches of the 8.8 inch total precipitation is effective. Average humidity is about 50 percent, and average annual pan evaporation is 49 inches.

The combination of low annual precipitation, cool temperatures, strong winds, and low humidity will contribute to the difficulty in revegetating the study area. Species selection and revegetation techniques will be important considerations in revegetation of the study area.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The study area is in the Navajo Section of the Colorado Plateau Physiographic Province. Landforms in the Navajo Section are in an early stage of dissection, characterized by young plateaus, mesas, hogbacks, retreating escarpments, and debris-choked dry-wash canyons.



T23N
T22N
R11W
R10W
EXPLANATION:
LAND CLASSIFICATION
ACRES
CLASS 1
2,821
CLASS 2
1,466
CLASS 6
7,873
TOTAL (SHEETS 1 & 2)
12,160
MATCH LINE TO SHEET 2
6
5
4
12
7
8
9
18
17
16
19
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2000
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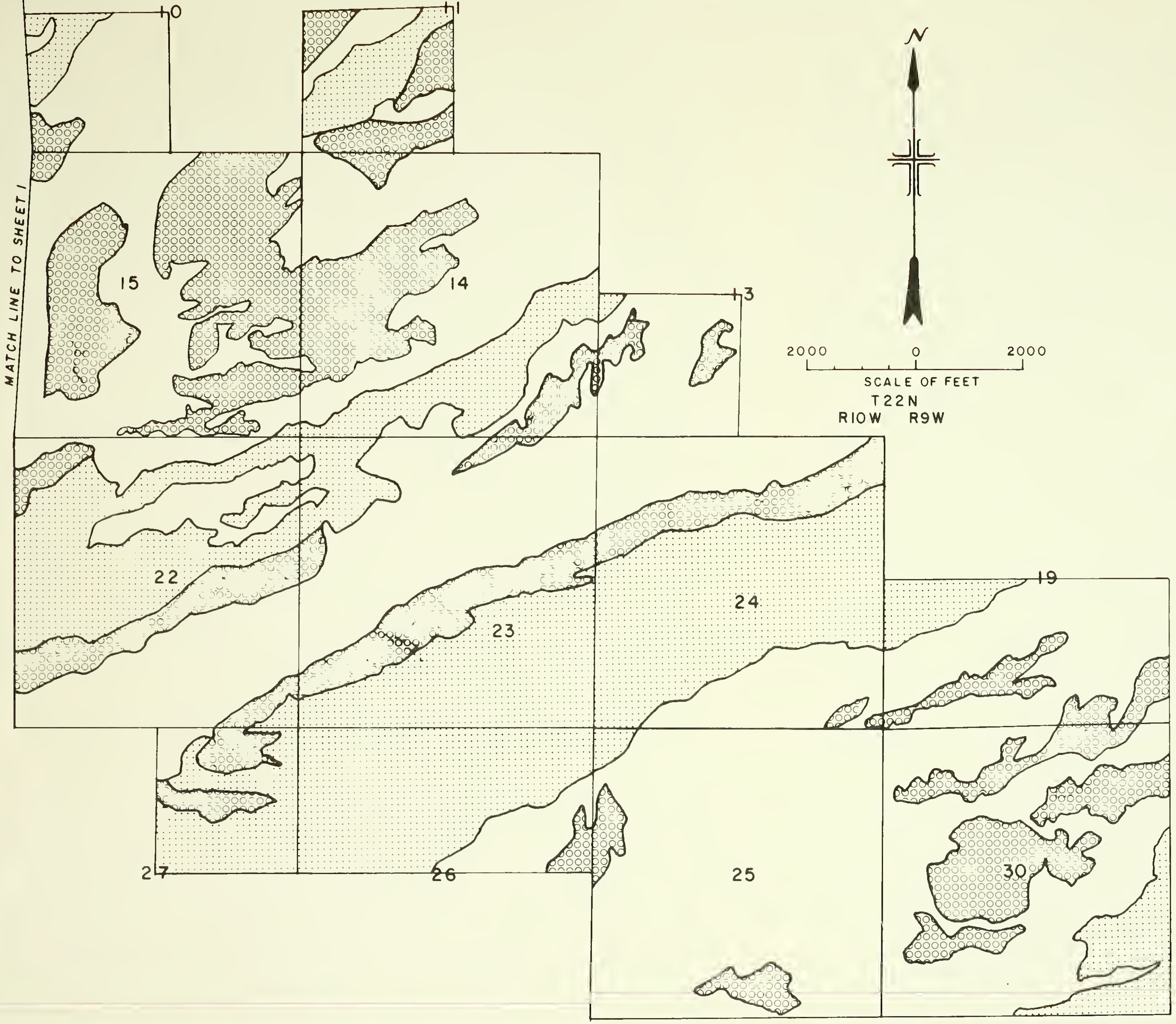
2000
SCALE OF FEET
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER AND POWER RESOURCES SERVICE
EMRIA REPORT NO. 17—77
KIMBETO STUDY AREA — NEW MEXICO
GENERAL
LAND CLASSIFICATION
DESIGNED
SUBMITTED
DRAWN
RECOMMENDED
CHECKED
APPROVED
AMARILLO, TEX.
SHEET 1 OF 2

Figure 2



EXPLANATION:

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ALWAYS THINK SAFETY

UNITED STATES
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EMRIA REPORT NO. 17-77
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GENERAL
LAND CLASSIFICATION

DESIGNED ______ SUBMITTED ______
DRAWN ______ RECOMMENDED ______
CHECKED ______ APPROVED ______

AMARILLO, TEX. JAN. 1979
SHEET 2 OF 2

Figure 2

In the study area, sharply contrasting landforms include boldly scarped mesas, starkly barren badlands, hummocky areas, inactive and active sand dunes, and sand-choked drainages. Elevations range from 6,160 to 6,420 feet above sea level over most of the study area. Drainage in the study area is to Ah-Shi-Sle-Pah, Kimbeto, and Betonnie Tsosie Washes, which flow southwest across the study area into Escavado Wash, which flows to the Chaco River, a left tributary to the San Juan River.

GEOLOGY

The dominant structural element of the region is the San Juan Basin, an asymmetrical structural and topographical depression roughly 125 miles long north-south and 100 miles wide east-west. Differential uplift in the region resluted in the basin's great, shallow bowl-like form. The perimeter of the basin, except on the south, is marked by sharp monoclinal flexures or faulting adjacent to the flanking mountains. The basin contains sediments ranging in age from Cambrian to Quaternary and having a maximum total thickness exceeding 14,000 feet in the deepest, or northern, part. Successively younger strata outcrop going from the margins of the basin toward its interior--the Central Basin. The study area is situated in the southwestern quadrant of the Central Basin, where rock formations dip gently northeast.

The rock formations outcropping in the study area are of Late Cretaceous and Tertiary Ages and, in descending order, are: the lower part of the Kirtland Shale consisting predominantly of shale; the Fruitland Formation, of shale, sandstone, coal, and siltstone; and the Pictured Cliffs Sandstone, of predominantly sandstone. All of the formations are weakly to only moderately lithified. "Hard rock" does not occur except for scattered ferruginous-cemented concretions in sandstone and siltstone beds in the Kirtland Shale and ferruginous-cemented thin sandstone beds in the Fruitland Formation.

In the study area, coal beds are confined to the Fruitland Formation and are thicker and more persistent in its lower part. Coal beds range from 0.1 to 40.7 feet in thickness, averaging about 5.4 feet in thickness. Depth of overburden above the upper coal beds ranges from less than 10 feet in the western part of the area to more than 260 feet in the northern part. Some Kirtland Shale overburden, Fruitland Formation overburden, and rock separating coal beds are excessively high in sodium and salts.

COAL RESOURCES

The coal beds are mainly in the lower 150 feet of the Fruitland Formation.

Coal resources--measured, indicated, and inferred--with less than 400 feet of overburden are 69,085,000 short tons, 369,078,000 short tons, and 177,803,000 short tons respectively. About 68 percent of the coal is overlain by 200 feet or less of overburden.

The apparent rank of the coal ranges between subbituminous A and subbituminous B. For 14 study area core samples, on an as-received basis, the average Btu value is 8,250, average ash content is 23.4 percent, and average sulfur content is 0.5 percent.

OVERBURDEN GEOCHEMISTRY

In principle and on the basis of their bulk chemistry, the overburden rocks could be used as acceptable soil replacement material and should not be expected to have long-term unfavorable effects on ground water element concentrations. The only apparent qualification on this general conclusion is that the sodium content of the rocks at the study area is distinctly higher than at other sites in other States where Cretaceous Age rock overlies mineable coal, and slightly higher than at sites in other States where Tertiary Age (Paleocene) rock overlies mineable coal.

As indicated above, the bulk chemistry of Kimbeto overburden rock is generally favorable with respect to postmining reclamation of the study area. However, for determining the immediate suitability of the rock as a replacement for the soils of the study area, other factors, such as texture, water holding capacity, permeability, salinity, sodicity, and weatherability must also be considered. These other factors were basis for the suitability determinations discussed in the following section, LAND AND OVERBURDEN.

It may be necessary to stockpile rocks in a segregated manner, by distinct rock types, in order to allow replacement of rocks after mining in positions best suited to their particular chemical character and to reclamation needs.

LAND AND OVERBURDEN

Land Suitability

Study area lands were surveyed in order to class them for their suitability as a source of material for resurfacing and revegetating the area following surface mining. The survey provided data on the quantity, quality, and ease of stripping and stockpiling the material. Assignment of classes was based on field observations laboratory analyses, and greenhouse studies. Three land classes were mapped at the study area--class 1 (good, 23 percent of study area); class 2 (fair, 12 percent); and class 6 (presently unsuitable, 65 percent). Land classes 1 and 2 have material suitable as planting media; class 6 has material presently unsuitable because of severe limitations. Figure 2 shows the extent and location of the three land classes.

Bedrock Suitability

Field investigations, greenhouse studies, laboratory analyses, and weathering tests indicate that most bedrock is presently unsuitable for use as planting media. Although bedrock materials should not be used in their present state, their use for reclamation purposes may be possible in conjunction with better materials, or after additives (such as gypsum or cinders) are applied, or with good postreclamation management. The usability of bedrock overburden for reclamation purposes needs researching.

Major Land Categories

Four major land categories encompass the landforms and soil bodies of the study area:

Mesas

About 25 percent of the study area consists of mesas, elevated benches, and sandy ridges. These areas generally have vegetation. Soil depth is usually 60 inches or more, soil textures range from fine sand to loam, and soil-moisture relationships (permeability and water-holding capacity) are generally good. Usually no harmful accumulations of chemical were detected in the surface soils; saline and sodic conditions exist in some of the subsoils however. Most of this land is suitable for use as a source of planting media.

Valleys

About 25 percent of the study area consists of valley lands, which were divided into two groups--sandy and saline-sodic. Depth to bedrock varies from 0 to at least 10 feet.

Sandy. Many small areas of sandy topsoil (9 percent of study area), varying in size and supporting vegetation, are scattered at elevations slightly higher than most valley areas. Textures usually range from sand to sandy loam, although some loam and clay loam soils are present. Generally, waterholding capacity is relatively low, especially in sandy surface soils, but adequate to support and maintain vegetation with proper management; some subsoils have very low or no permeability. Most surface soils and sandy subsoils have no harmful accumulations of chemicals, but most other subsoils have excessive salinity or sodium or both. Most sandy lands are suitable for use as a source of planting media but are subject to severe wind erosion.

Saline-sodic. These lands (16 percent of study area) are nearly level or very gently sloping. They are usually barren or have scattered sparse vegetation. Scattered throughout are areas of desert pavement, slick spots, surface crusting, and coppice mounds. Except for very shallow sandy eolian material on scattered areas, soils have developed from alluvial material. Textures usually range from loamy sand to clay. Permeability varies; but where a high amount of a high amount of sodic material occurs, moisture penetration is very restricted or eliminated. Most of these lands, except the shallow eolian deposits, are presently unsuitable as a source of planting media.

Badlands

About 41 percent of the study area consists of badlands. Generally, these lands have rough topography consisting of deep drainage channels entrenched in soft shales and sandstone. Almost all these lands are barren. Where soils are present, they are thin and poorly developed; textures range from sandy loam to clay. Because of restricted permeability, strong sodicity, and high salinity, these soils are considered unsuitable in their present condition for use as a source of planting media.

Miscellaneous

About 9 percent of the study area, categorized as miscellaneous lands, consists of active dunes, hummocky areas, and stream channels.

Active dunes. Most of the active dunes consist of undulating ridges and small hills and are barren and subject to severe wind erosion. Textures are usually fine sand and sand. Because of their excessive permeability, low water-holding capacity, and erosion hazard, these soils are considered unsuitable for planting media in their present state; however, mixing with better materials could produce satisfactory planting media.

Hummocky areas. These lands usually occur in association with inactive dunes and are usually rough and undulating. Vegetation consisting mostly of shrubs nearly covers these areas. Small blowouts are scattered throughout. Textures range from fine sand to sandy clay, and water-holding capacity is generally poor. The condition of surrounding soils indicates that some saline-sodic conditions interspersed with coarse textured soils can be expected in hummocky lands. The fact that these lands presently support vegetation indicates that they could be considered as a source of planting media. However, special care must be taken to prevent severe wind erosion when the vegetative cover is removed.

Stream channels. These lands are composed of deposits associated with major drainage systems. They are usually barren. Soils are subject to severe wind erosion. Textures are usually sandy with deposits of gravel and cobble, and water-holding capacity is very poor. Stream channel soils are considered unsuitable for planting media.

VEGETATION

The vegetation of the study area is a part of the southern-most extent of the northern desert shrub type. Typical northern desert shrub species present are big sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), and rubber rabbitbrush (*Chrysothamnus nauseosus*). Galleta (*Hilaria jamesii*) and ring muhly (*Muhlenbergia torreyi*), also abundant, are typical only of the southern portion of the northern desert shrub type. Other species that are present in significant amounts include alkali sacaton (*Sporobolus airoides*), blue grama (*Bouteloua gracilis*), Greene's rabbitbrush (*Chrysothamnus greenei*), false buffalograss (*Munroa squarrosa*), and Russian thistle (*Salsola kali*).

In general, the area has low vegetation productivity. Factors contributing to low plant yields include: low precipitation (about 9 inches annually); high runoff associated with intense summer thunderstorms, particularly from clayey badlands and poorly permeable alluvial plains; and replacement or reduction in vigor of palatable and productive species by years of excessive use by livestock.

SOIL-MOISTURE RELATIONSHIPS ASSOCIATED WITH VEGETATION TYPES AND LANDFORMS

The vegetative productivity of a soil is dependent on the availability of moisture. Unless plant roots are in contact with a water table or the moist zone above it, all of the moisture is obtained from precipitation and from run-in. In order for vegetation to best use this moisture, it must be stored, at least temporarily, in the profile at stresses low enough for the plant roots to absorb it. This is controlled by profile configurations of both moisture-retention capability, which is a function of soil texture, and void capacity, which is a function of soil bulk density.

In terms of galleta or alkali sacaton production, it is most efficient to have a surface layer of coarse material (such as sandy loam) with a large void capacity over finer material with less void capacity to the rooting depth. At the rooting depth, a compacted layer of spoil with constricted voids would impede drainage. These are the naturally-occurring soil conditions that exist in the most productive sites in the study area. These sites occur on some dunes and on certain part of mesas.

Sandy material on the surface facilitates infiltration and reduces evaporation, but during revegetation a mulch of some type would be required to stabilize the sandy material until the vegetation is established. The finer-textured soil beneath would retain moisture within the root zone of grasses.

Greasewood and rubber rabbitbrush utilize ground water from alluvial aquifers and serve to partially stabilize dunes that occur adjacent to the main washes. Alkali sacaton does not require ground water to thrive and is much more effective in stabilizing dunes.

The fine-textured materials of the badlands and alluvial plains are generally unproductive. A relatively large percentage of the precipitation that falls on these areas runs off, or if it becomes soil moisture, it is stored near the surface where much is lost by evaporation.

SEDIMENT YIELDS

Sediment yields from source areas range from low to very high. Lowest yields are from dunes adjacent to main channels, from alluvial plains partially mantled with low dunes, and from mesas. Those areas tend to have the gentlest slopes and the most vegetation cover. Moderate yields occur from rilled or gullied alluvial fans and plains and from moderately steep hillslopes that are not mantled with sand. The relatively barren badlands yield sediment at high to extremely high rates depending upon local relief and upon the local extent of cohesive bentonite beds. Significant sediment is contributed from erosion of the bands and beds of tributary channels, but the channels of the main washes are relatively stable.

Sediment discharge from small drainage basins, 0.4 to 8 mi^2, range from low to high. This variation is caused chiefly by differences in yields from the source areas within basins.

If the area is mined, diversion channels would be necessary to prevent flooding of the mine by flows of Ah-shi-sle-pah Wash and from the tributaries that arise in the badland areas that lie north and south of the Wash. The diversion channels will have to be lined to prevent erosion and structures will be needed at mouths of tributary channels to prevent headward downcutting of those channels.

Utilization of the sandy deposits on meses and along the main washes as topping material after mining and reshaping would greatly reduce the high sediment production from badland areas and increase forage production on them.

Sedimentation ponds should effectively control the sediment from haul roads, coal-handling and equipment-maintenance areas, and temporarily unreclaimed spoil areas.

HYDROLOGY AND WATER SUPPLY

The streams in the Kimbeto study area are ephemeral; that is, flow occurs only in direct response to storm runoff. Much of the surface runoff occurs during July through September as a result of localized, high-intensity rainfall from thunderstorms of short duration. The highest runoff volumes in the study area are produced from the badlands, which occupy about 40 percent of the drainage area.

The chemical quality of the first surface runoff after long periods of little or no flow is poorer than the runoff that occurs following the inital flow. The chemical quality of the runoff appears to be a function of the percent of badlands on a drainage area. As the percent of badlands in a drainage area increases, the salinity of the runoff increases.

The dissolved-solids concentration of surface water is generally about 500 milligrams per liter (mg/L); the predominate ions are sodium, bicarbonate, and sulfate. Dissolved trace elements and radiochemical constituents were found to be low or below detection limits; however, high total (dissolved plus suspended) trace element concentrations were found in the surface runoff because of the high suspended-sediment concentrations.

High suspended-sediment concentrations accompany all surface runoff in the study area. Suspended-sediment concentrations are higher in surface runoff resulting from rainfall than snowmenlt. As the percent of badlands in a drainage area increases, the suspended-sediment concentration of the runoff increases.

Several deep, high yielding water-bearing units or aquifers exist at the study area. In descending order, these water-bearing aquifers are Cliff House Sandstone, Menefee Formation, Morrison Formation, and Entrada Sandstone. The highest yielding units are the Morrison Formation and Entrada Sandstone. These formations are capable of producing about 400 gallons per minute. Drilling and testing the Cliff House Sandstone, Menefee Formation, Morrison Formation, and Entrada Sandstone would be required to determine the suitabilities of yields and water quality for reclamation and mining at the study area. The channel alluvium of Kimbeto and Betonnie Tsosie Washes provides a limited supply of water.

Surface-mining coal and subsequent reclamation would have some impact on the hydrologic budget in the Kimbeto study area. Mining would breakup the water-bearing overburden and coal seam. Limited or no use is being made of this shallow ground water supply because it is low yielding and the water is saline. If sandy material is distributed over the mined area, including that which is presently badlands, the long-term effects may be a reduction in surface-runoff volumes, reduction in suspended-sediment loads, and improvement in chemical water quality of the runoff.

Revegetation of reclaimed spoil piles within a reasonable time will require irrigation at the Kimbeto study area. Water supply is available from surface runoff and ground water. However, the surface runoff is variable from year to year, and water quality and yield from deep water-bearing aquifers have not been determined. Collection of surface runoff would deprive downstream users, but the effect would be short term.

The water quality of the surface water is generally suitable for reclamation purposes with no problems foreseen with salinity or sodium. The concentrations of dissolved trace elements in the surface waters are very low and will not affect plant growth. High trace-element concentrations found adsorbed to the suspended sediment are not likely to dissolve because of the high alkalinity of the water and soil.

The quality of the ground water from nearby wells in the alluvium may be suitable for a reclamation supply. Other ground water supplies would probably required blending with a surface supply to reduce the salinity or sodium levels.

Compliance with State and Federal water-quality standards will be required during mining and reclamation. The·most stringent State or Federal regulations would apply.